

The cleared property would be allowed to revert back to native vegetation, with limited plantings in some areas. If this alternative was selected for final detailed design, some areas could be graded for ponding/wetlands to occur. It was assumed, in particular, that limited ecosystem restoration would occur along the confluence of Mill Creek and East Fork Mill Creek. (e.g., creation of small hardwood wetland areas) in coordination with the Sponsor. The previously constructed sections of the Mill Creek channel would not be disturbed, except for the creation of riffles about every 500 feet to improve fish habitat and trees planted along the banks every 200 feet on both sides. This plan does not attempt to provide for major ecosystem restoration of the entire cleared portions of the 1%-chance floodplain, but neither does it preclude such work by others in the future.

A 10-foot wide asphalt bike trail would be constructed along the channel within the right-of-way in sections 4, 5, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

The Flood Warning System to be installed in July 2003 would be adjusted to account for the warning needs of the NS-3 alternative.

#### **10.5.2 Hydrology & Hydraulics**

The ring levees and floodwalls included in the NS-3 alternative would result in some change in overbank storage, thereby changing the extent of frequency flood flows. However, it was assumed these changes in storage would be minimal because many of the structures to be protected already have some level of protection, and the clearing of other floodplain land would tend to offset the loss of storage. In general, all other hydraulic assumptions were considered to be the same as those of the NS alternative. Refer to Appendix IV for the water surface profiles for the WO alternative.

#### **10.5.3 Environmental**

The environmental impacts of the NS-3 alternative would be similar to the NS alternative, as described before in Section 10.3.3. However, NS-3 would allow a larger acreage of habitat to be available for the return of the land to riparian habitat types in various successional stages.

**TABLE 10.5.4.2**  
**Average Annual Cost for NS-3 Alternative**

<b>First Cost</b>	<b>Interest During Construction</b>	<b>Avg Annual First Cost (2011)</b>	<b>Avg Annual O&amp;M</b>	<b>Avg Annual Alternative Cost (2011)</b>	<b>Avg Annual Cost (2010)</b>
\$921,018,000	\$118,718,000	\$64,817,000	\$180,000	\$64,997,000	\$61,390,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

#### **10.5.4b Benefit Analysis**

Similar to the NS-3 derived cost estimates, the NS-3 overbank flooding damage estimates were derived based on the NS alternative estimated overbank flooding damages and the RL alternative estimated overbank flooding damages. The NS-3 overbank flooding damages would be less than the NS alternative overbank flooding damages by the amount of overbank damage occurring to those structures located in between the 4% chance and 1% chance floodplains. These structures would be removed under the NS-3 alternative. The difference in overbank flood damage between the NS alternative and the RL alternative (the RL alternative would relocate all structures in the 4% chance floodplain) was used to estimate the damage associated with the protected high value/damage facilities. The value was used as the minimum overbank flood damage associated with the NS-3 alternative. As indicated on Table 10.5.4.3, the total average annual damages for the NS-3 alternative was estimated at \$10,751,000 (base year 2011). The With-Project damages from direct overbank flooding would be \$1,351,000, or about a 98 percent reduction from the Without-Project damages of \$57,350,000 (per Table 10.1.4.1).

**TABLE 10.5.4.4**  
**Benefit Calculations for NS-3 Alternative**

<b>WO Alternative Damage (2011)</b>	<b>NS-3 Alternative Damage (2011)</b>	<b>Avoided O&amp;M Cost</b>	<b>Annual Benefit (2011)</b>	<b>Adjusted Annual Benefit (2010)</b>
\$67,226,000	\$10,751,000	\$34,000	\$56,509,000	\$53,374,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

#### 10.5.4c Economic Evaluation

The economic feasibility of the NS-3 alternative was determined by comparing the benefits and the costs (Table 10.5.4.5). The NS-3 alternative has a BCR less than 1.0, indicating that it is not economically justifiable.

**TABLE 10.5.4.5**  
**Economic Evaluation of NS-3 Alternative (base year 2010)**

<b>Annual Benefit</b>	<b>Annual Cost</b>	<b>BCR</b>	<b>Annual Net Benefit</b>
\$53,374,000	\$61,390,000	0.87	(\$8,016,000)

Notes: price level in 2002 dollars

#### 10.5.5 Summary

The NS-3 Alternative, is considered engineeringly feasible, and is complete and effective in meeting the primary objective of providing flood damage reduction. However, preliminary estimates indicate that the NS-3 alternative is not cost efficient. The NS-3 alternative may not be acceptable to the Sponsor and the local communities. This is because of the impact on local communities due to the relocation of businesses and residences creating a significant cost and revenue loss to their tax base. The NS-3 alternative would not disturb the existing channel of Mill Creek. As part of the ecosystem restoration, trees would be planted at the top of the banks every 200 ft. in the completed sections (1, 2, 3, and 4A) with riffle structures added to the stream every 500 ft. on alternate sides. Streambed improvements would be made for aquatic habitat. All excavated special waste would be disposed of in accordance with regulations and in a designated landfill.

The NS-3 alternative does not satisfy the evaluation criteria of the USACE planning guidelines as listed in Section 2.4; namely NS-3 fails under the criteria of "efficiency" since the alternative has no positive net economic benefits, and also fails "acceptability" due to the significant loss of tax base and employment in the study area.

**TABLE 10.6.1.2**  
**Demolition Quantities for CM Alternative**

Section	Residential Structures	Commercial Structures	Roadway (sy)	Bridges
8	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	116	5	32,000	6
5	0	0	0	1
6	0	0	0	8
7	0	0	0	3
<b>Total</b>	<b>116</b>	<b>5</b>	<b>32,000</b>	<b>18</b>

Excess suitable soils can be resold for use as backfill elsewhere. Contaminated materials disturbed during construction would be disposed of in a regulated landfill in accordance with State and Federal regulations.

Trees and/or other vegetation would be planted along the upper banks of the entire mainstem and riffles would be created every 500 feet to improve fish habitat.

Bike trails would be constructed along the channel within the right-of-ways in sections 2, 4, 5, 6, and 7. Other recreational complements could be developed where continuous tracts of land would be available.

The Flood Warning System to be installed in July 2003 would be adjusted for the warning needs of the CM alternative.

### **10.6.2 Hydrology & Hydraulics**

The CM alternative is a continuation of the design of the Authorized Plan. The increase in channel capacity with completion of this alternative would increase discharges at the downstream sections. It is not unusual for channel modifications to cause an increase in peak downstream discharges. The CM alternative would increase the quantity and velocity of flow in the channel, causing downstream flows to concentrate more rapidly. The reductions in flood stages also correspond with reductions in floodwater ponding in the overbank areas. Under existing conditions, the peak downstream flows are reduced as floodwater is temporarily stored in the overbanks. With the CM alternative, the flood stages would be lowered, reducing the volume of water stored in the overbanks. The removal and/or replacement of some of the 18 hydraulically undersized bridges would also increase downstream flows, reducing the volume of flow that would pond and be stored in the floodplain, thus increasing the maximum rate of flows.

It should be emphasized that for this analysis the channel modification was designed to keep the future 1% chance flow off buildings and roads and not within banks. Consequently,

**TABLE 10.6.4.1**  
**Real Estate Costs for CM Alternative**

<b>Component</b>	<b>Acres</b>	<b>Unit Value</b>	<b>Total Value</b>
Fee Simple	54		\$17,000,000
Minerals [None]			\$0
Timber [None]			\$0
Fee Improvements [Included in Fee]			\$0
<b>Easements</b>			
Permanent Levee Easement	8		\$320,000
Channel Improvement Easement	254		\$9,728,000
Permanent Road Easement	0.4		\$4,000
Temporary Work Area Easement	75		\$953,000
Severance Damages [None]			\$0
Total Land, Improvements, and Damages	391.4		\$28,005,000
Contingency (35%)			\$9,802,000
			\$37,807,000
<b>TOTAL ESTIMATED LAND COSTS</b>			<b>\$37,800,000</b>
Relocations			\$7,105,000
Administration; 320 Tracts			
Non-Federal Administrative Costs [\$5,000]			\$1,600,000
<b>TOTAL LERRD</b>			<b>\$46,505,000</b>
Federal Administrative Costs [\$5,000]			\$1,600,000
			\$48,105,000
<b>TOTAL REAL ESTATE COSTS (Rounded)</b>			<b>\$48,000,000</b>

Notes: price level in 2002 dollars

The cost estimate for the CM alternative was based on an estimate that had been prepared in 1991. The quantities were revised to account for the alignment change around the two landfills. Current cost databases have been used in MCACES, including updated labor costs for Hamilton County, Ohio.

The cost estimate for the CM alternative included construction; real estate; environmental mitigation; construction management; planning, PED; and mobilization/demobilization. The CM alternative cost estimate is \$487,487,000 (Table 10.6.4.2).



**10.6.4b Benefit Analysis**

The HEC-FDA program was used to estimate flood damage to structures in the study area for the CM alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the CM alternative was estimated at \$12,257,000 (base year 2012). Table 10.6.4.4 displays the damage estimates for selected years.

**TABLE 10.6.4.4**  
**Average Damage Estimates for CM Alternative (thousands of dollars)**

Year	N <sup>12</sup>	Overbank Flooding	Sewer Back-up	Total
2002		\$35,409	\$9,400	\$44,809
2003		\$37,200	\$9,400	\$46,600
2004		\$39,000	\$9,400	\$48,400
2005		\$40,800	\$9,400	\$50,200
2006		\$42,600	\$9,400	\$52,000
2007		\$44,400	\$9,400	\$53,800
2008		\$46,200	\$9,400	\$55,600
2009		\$48,000	\$9,400	\$57,400
2010		\$49,800	\$9,400	\$59,200
2011		\$51,600	\$9,400	\$61,000
2012	1	\$2,621	\$9,400	\$12,021
2013	2	\$2,709	\$9,400	\$12,109
2014	3	\$2,798	\$9,400	\$12,198
2015	4	\$2,888	\$9,400	\$12,288
2016	5	\$2,888	\$9,400	\$12,288
2021	10	\$2,888	\$9,400	\$12,288
2026	15	\$2,888	\$9,400	\$12,288
2031	20	\$2,888	\$9,400	\$12,288
2036	25	\$2,888	\$9,400	\$12,288
2041	30	\$2,888	\$9,400	\$12,288
2046	35	\$2,888	\$9,400	\$12,288
2051	40	\$2,888	\$9,400	\$12,288
2056	45	\$2,888	\$9,400	\$12,288
2061	50	\$2,888	\$9,400	\$12,288
Total		\$143,848	\$470,000	\$613,848
Present Value (2012)		\$45,834	\$150,786	\$196,620
Avg Annual Damage (2012)		\$2,857	\$9,400	\$12,257

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

<sup>12</sup> "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

## 10.7 CHANNEL MODIFICATION 2

### 10.7.1 Description and Features

The CM-2 alternative is similar to the CM alternative in that it would involve modifying the channel to provide protection against a 1% chance flood event. However, the CM-2 alternative would utilize current USACE philosophies of environmental sustainability by incorporating bioengineering when designing the channel. Bioengineering and a minimum amount of riprap would be utilized in the implementation of this alternative. The previously constructed portions of Mill Creek would be left as is. Maps showing areas of impact for the CM alternative can be found in Appendix IX. These maps should be used to estimate the impacts and alignment of the CM-2 alternative.

The CM-2 alternative assumes that widening of the channel would predominately be on one bank only. Riprap would be placed on the toe of the disturbed bank up a vertical height of four feet, which equates to the approximate ordinary high water (OHW) elevation. The riprap would be underlain with a filter stone to prevent the migration of soil out of the bank which would cause erosion of the excavated bank. The riprap design consisted of 18 inches of ODOT Type C stone underlain with 6 inches of ODOT Type #1 or #2 bedding. Above the top of the riprap toes on the disturbed bank, an erosion control fabric would be staked in place. A 10 ft band of live stakes (black willow, red twig dogwood and buttonbush) – four rows of stakes placed at 2.5 ft centers in a diamond configuration - would be placed on the disturbed bank beginning 1 ft above the riprap toes. The length of stakes would be 3 ft, with 6 inches protruding out of the bank. Table 10.7.1.1 presents the construction quantities for the CM-2 alternative. Construction on the CM-2 alternative would begin in 2007 and be completed in 2011.

**TABLE 10.7.1.1**  
**Construction Quantities for CM-2 Alternative**

Section	1-wall (lf)	Channel Modification (lf)	Road Closures	Bike Trails (lf)	Riffles and Trees
8	0	0	0	0	Yes
1	0	0	0	0	Yes
2	5,600	0	1	5,740	Yes
3	0	0	0	0	Yes
4	0	10,575	0	4,250	Yes
5	0	7,925	0	0	Yes
6	0	19,605	0	11,200	Yes
7	0	23,435	0	9,300	Yes
<b>Total</b>	<b>5,600</b>	<b>61,540</b>	<b>1</b>	<b>30,490</b>	<b>N/A</b>

Notes: Quantities are for construction on mainstem and tributaries.

A few areas would require floodwalls to provide the desired protection. Channel modifications would also be needed for the following streams to remove tributary headwater

The CM-2 alternative would have higher roughness coefficients with the proposed channel raised above the existing channel bottom. The authorized CM alternative included excavation of the channel to provide more flow capacity. For these reasons, the CM-2 alternative required a much wider channel than the CM. The width of the channel was sized so that the 1% chance flood elevation for this alternative would be equal to that of alternative CM.

### 10.7.3 Environmental

CM-2 would disturb existing vegetation and fish and wildlife habitats, particular to narrow strips of riparian habitat that exist where no previous stream modifications have been made. However, the bio-engineered channel would not preclude future opportunities to implement some type of stream and riparian restoration. Alternative CM-2 would include advanced environmental design techniques -- including side-slope bioengineering and environmentally sustainable design elements.

Trees planted along the mainstem would promote reduction of the thermal burden in the surface water of the creek by shading, thus lowering the ambient water temperature. However, practical benefits to fish and wildlife would likely be limited.

In-channel improvements would be undertaken as a component of this alternative and would be limited to boulder and cobble constructions at 500-foot intervals within the main channel to create artificial riffles to improve fish habitat. The artificial riffle areas would provide flow modification and serve as physical water energy dissipaters under normal flow conditions. The riffle areas would create re-oxygenated water to provide a more diverse habitat for a wider range of aquatic organisms.

Improvements to water quality would result from the reduction of CSOs, which would be addressed by MSD's CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002). Additional water quality improvements could also result from protecting industrial facilities. Protecting industrial facilities, which often use various solvents and other chemicals in their manufacturing processes, from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

### 10.7.4 Economics

#### 10.7.4a Cost Analysis

The real estate cost estimate was based on the cost to acquire the necessary land and easements to construct the CM-2 alternative. In accordance with ER 405-1-12, Chapter 5, Estates, the following estates are applicable: Estate 1, Fee, and Estate 9, Flood Protection Levee Easement are required for real estate acquisition. The estimated cost for real estate acquisition is \$49 million (Table 10.7.4.1).



**TABLE 10.7.4.2**  
**Total Cost Estimate for CM-2 Alternative**

Feature	Cost
Section 1	\$8,000
Section 2	\$7,498,000
Section 3	\$15,000
Section 4A	\$13,000
Section 4 B	\$136,066,000
Section 5	\$37,446,000
Section 6	\$103,683,000
Section 7	\$234,819,000
Section 8	\$12,000
Real Estate	\$49,000,000
Environmental Mitigation	\$19,800,000
Construction Management	\$27,720,000
PED	\$47,520,000
Mobilize/Demobilize	\$11,880,000
Utility Conflicts	\$5,940,000
Traffic Control	\$1,980,000
<b>TOTAL</b>	<b>\$683,399,000</b>

Notes: price level in 2002 dollars

Completion of the CM-2 alternative is estimated for 2011, with the alternative base year being 2012. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2012 alternative base year is estimated at \$50,289,000 (Table 10.7.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at \$44,863,000. See Appendix V for detailed life cycle costs.

**TABLE 10.7.4.3**  
**Average Annual Cost for CM-2 Alternative**

First Cost	Interest During Construction	Avg Annual First Cost (2012)	Avg Annual O&M	Avg Annual Alternative Cost (2012)	Avg Annual Cost (2010)
\$683,399,000	\$121,368,000	\$50,170,000	\$119,000	\$50,289,000	\$44,863,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

### 10.7.4b Benefit Analysis

The HEC-FDA program was used to estimate flood damage to structures in the study area for the CM-2 alternative, while a separate analysis was used to estimate the damage to basements

**TABLE 10.7.4.5**  
**Benefit Calculations for CM-2 Alternative**

<b>WO Alternative Damage (2012)</b>	<b>CM-2 Alternative Damage (2012)</b>	<b>Avoided O&amp;M Cost</b>	<b>Annual Benefit (2012)</b>	<b>Adjusted Annual Benefit (2010)</b>
\$67,618,000	\$12,257,000	\$34,000	\$55,395,000	\$49,418,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

#### **10.7.4c Economic Evaluation**

The economic feasibility of the CM-2 alternative was determined by comparing the benefits and the costs (Table 10.7.4.6). The CM-2 alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

**TABLE 10.7.4.6**  
**Economic Evaluation of CM-2 Alternative (base year 2010)**

<b>Annual Benefit</b>	<b>Annual Cost</b>	<b>BCR</b>	<b>Annual Net Benefit</b>
\$49,418,000	\$44,863,000	1.10	\$4,555,000

Notes: price level in 2002 dollars

#### **10.7.5 Summary**

The CM-2 alternative completely and effectively meets the objective of providing flood damage reduction, but the channel work would disturb some existing vegetation and fish and wildlife habitats. Hazardous material (special waste) disturbed during construction or excavation of this alternative would be disposed of in a designated landfill and in accordance with applicable regulations. Depending on the final design and alignment, community response to this alternative could range from moderate to unacceptable. Estimates indicate that the CM-2 alternative would be cost effective.

The CM-2 alternative does satisfy the four evaluation criteria of the USACE planning guidelines listed in Section 2.4. However, because of the high initial cost, the plan has relatively low net benefits compared to the other alternatives with positive net benefits.

A small number of residential structures would need to be removed for the construction of the floodwalls and levees (Table 10.8.1.2).

**TABLE 10.8.1.2**  
**Demolition Quantities for FW Alternative**

Section	Residential Structures	Commercial Structures	Roadway (sy)	Parking (sy)
8	0	0	0	0
1	0	0	0	0
2	1	0	0	0
3	0	0	0	0
4	1	0	0	0
5	0	0	0	0
6	8	0	0	0
7	1	0	0	0
<b>Total</b>	<b>11</b>	<b>0</b>	<b>0</b>	<b>0</b>

The previously constructed sections of the Mill Creek channel would be left as is, except for the creation of riffles about every 500 feet to improve fish habitat and trees planted along the banks.

The Flood Warning System to be installed in July 2003 would be adjusted for the warning needs of the FW alternative.

### 10.8.2 Hydrology & Hydraulics

The screening-level design for the FW alternative assumes that the top of protection is 3 feet above the calculated 1% chance event water surface. In some locations the walls would constrict flows, inducing upstream flooding. Modifications would be required to the Beaver Run/Champions Tributary, Kemper Road Tributary, Keebler Tributary, and Sharon Creek. Levees and floodwalls also trap runoff on the interior side of the line of protection. It was assumed that the interior storage or pumping capacity would be equivalent to the existing storm sewer capacity. If detailed floodwall/levee alternatives are developed, the capacity and design of each interior system would be formulated using the computer program "Interior Flood Hazard." Refer to Appendix IV for the water surface profiles for the FW alternative.

### 10.8.3 Environmental

The FW alternative would restrict ecosystem restoration to locations along the mainstem where right-of-way would be available. Trees would be planted along the previously channelized sections (1, 2, 3, and 4A) of the mainstem to promote riparian tree canopy development and lowering the ambient water temperature. However, practical benefits to fish and wildlife would likely be limited.

**TABLE 10.8.4.1**  
**Real Estate Costs for FW Alternative**

Component	Acres	Unit Value	Total Value
Fee Simple (None)			\$0
Minerals (None)			\$0
Timber (None)			\$0
Fee Improvements (None)			\$0
<b>Easements</b>			
Permanent Levee Easement	170		\$14,891,000
Permanent Road Easement	2		\$43,000
Temporary Work Area Easement	30		\$773,000
Severance Damages (None)			\$0
Total Land, Improvements, and Damages	202		\$15,707,000
Contingency Plus Rounding			\$5,498,000
<b>TOTAL ESTIMATED LAND COSTS</b>			<b>\$21,205,000</b>
Relocations (Facilities – Street Closure)*			\$0
(Business – 6)			\$500,000
Administration: 450 Tracts			
Non-Federal Administrative Costs (\$5,000)			\$2,250,000
<b>TOTAL LERRD</b>			<b>\$23,955,000</b>
Federal Administrative Costs (\$5,000)			\$2,250,000
			\$26,205,000
<b>TOTAL REAL ESTATE COSTS (Rounded)</b>			<b>\$26,000,000</b>

Notes: price level in 2002 dollars

\*All Costs Included in Engineering Cost Estimate

For the purpose of cost estimates, the elevation of the levees and floodwalls was set 3 feet higher than the 1% chance flood elevation. The height of the walls would be refined at a later stage of the GRR when risk and uncertainty are factored in.

The cost estimate for the FW alternative includes construction; real estate; environmental mitigation; construction management; planning, PED; and mobilization/demobilization. The FW plan cost estimate is \$607,701,000 (Table 10.8.4.2).

FW alternative was estimated at \$12,282,000 (base year 2014). Table 10.8.4.4 displays the damage estimates for selected years.

**TABLE 10.8.4.4**  
**Average Damage Estimates for FW Alternative (thousands of dollars)**

Year	N <sup>14</sup>	Overbank Flooding	Sewer Back-up	Total
2002		\$35,409	\$9,400	\$44,809
2003		\$37,200	\$9,400	\$46,600
2004		\$39,000	\$9,400	\$48,400
2005		\$40,800	\$9,400	\$50,200
2006		\$42,600	\$9,400	\$52,000
2007		\$44,400	\$9,400	\$53,800
2008		\$48,000	\$9,400	\$55,600
2009		\$49,800	\$9,400	\$57,400
2010		\$51,600	\$9,400	\$59,200
2011		\$53,400	\$9,400	\$61,000
2012		\$55,200	\$9,400	\$62,800
2013		\$2,798	\$9,400	\$64,600
2014	1	\$2,888	\$9,400	\$12,198
2015	2	\$2,888	\$9,400	\$12,288
2016	3	\$2,888	\$9,400	\$12,288
2017	4	\$2,888	\$9,400	\$12,288
2018	5	\$2,888	\$9,400	\$12,288
2023	10	\$2,888	\$9,400	\$12,288
2028	15	\$2,888	\$9,400	\$12,288
2029	16	\$2,888	\$9,400	\$12,288
2030	17	\$2,888	\$9,400	\$12,288
2031	18	\$2,888	\$9,400	\$12,288
2032	19	\$2,888	\$9,400	\$12,288
2033	20	\$2,888	\$9,400	\$12,288
2038	25	\$2,888	\$9,400	\$12,288
2043	30	\$2,888	\$9,400	\$12,288
2048	35	\$2,888	\$9,400	\$12,288
2053	40	\$2,888	\$9,400	\$12,288
2058	45	\$2,888	\$9,400	\$12,288
2063	50	\$2,888	\$9,400	\$12,288
Total		\$144,294	\$470,000	\$614,294
Present Value (2014)		\$46,236	\$150,786	\$197,022
Avg Annual Damage (2014)		\$2,882	\$9,400	\$12,282

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

The total annual benefits of the FW alternative were calculated by taking the damages from the WO alternative and subtracting the damages of the FW alternative, and then adding

<sup>14</sup> "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.



## 10.9 DEEP TUNNEL

### 10.9.1 Description and Features

TU alternative would involve the construction of a deep tunnel to handle a portion of the flood flows along Mill Creek. For this screening level analysis, the design and alignment of the tunnel would be identical to the plan developed in the MSD-sponsored Parsons-Brinckerhoff report of March 2002, entitled *Flood Control and CSO Tunnel*. The tunnel would begin at the confluence of Mill Creek and East Fork Mill Creek (near the Butler County line) and continue downstream over 17 miles to the Barrier dam and would provide protection up to the 1% chance flood event. A significant benefit of the TU alternative would be its ability to handle a portion of the CSOs that contribute to water degradation in Mill Creek. The tunnel would have the ability to store CSO contaminated water up to a 50% chance storm event while awaiting treatment. Maps showing the approximate alignment of the TU alternative and the locations of the drop inlets can be found in Appendix XI.

The TU alternative involves the construction of approximately 16 miles of 31-foot diameter tunnel. The tunnel would be bored through a hard limestone layer ("Lexington Limestone") at an average depth of 300 feet beneath the surface. Temporary support consisting of rock bolts and permanent lining consisting of a cast-in-place concrete were recommended. Seven intake shafts for flood water and twenty drop shafts for CSO flows would be located along the length of the tunnel. The vertical intake or drop shafts provide the means for surface creek floodwaters or overflow sewer water, respectively, to reach the much deeper 31-foot diameter tunnel. The design and location of the drop shafts was based on hydraulic input, local site conditions, geotechnical data, and other relevant information and would determine the alignment of the tunnel. Even though it would be empty a high percentage of the time, the tunnel would be designed in such a way as to minimize sedimentation. Flow velocities and shear stresses would be examined and a final grade of the tunnel determined during later stages of the GRR.

In addition to the deep tunnel, a few short levee segments and floodwalls along Mill Creek channel would be required to protect the study area to the 1% chance flood level and to prevent induced stages upstream into Butler County. Automatic gate-closures would be installed where roads cross a floodwall. Some channel modifications consisting of widening and lining with a rip-rap toe would be required in section 7. No residential or commercial structures would be demolished during the implementation of the TU alternative. Construction of the TU alternative would begin in 2007 and be completed in 2016.

flooding. The HEC-1 computer program was used to route the remaining flows downstream, add the local flows, and divert the excess flow into the tunnel. The total tunnel flow at the Barrier Dam has been determined to be 9,700 cfs. This corresponds to a tunnel diameter of 31 feet, assuming a 75-foot head loss.

Table 10.9.3.1 summarizes the discharges that need to be diverted into the various intake structures, as well as the accumulated tunnel flows.

**TABLE 10.9.3.1**  
**Intake Structure Flows - Accumulated Tunnel Flows**

<b>Location of Intake Structures</b>	<b>Flow (cfs)</b>	<b>Tunnel Flow (cfs)</b>
Upper Kemper Road Tributary (Mile 0.8)	400	
Lower Kemper Road Tributary (Mile 0.3)	1,000	
Confluence of Mill Creek with East Fork (Station 1962+00)	5,200	5,200
Confluence of Mill Creek with Town/UPS Tributary (Station 1905+00)	2,400	7,100
Mill Creek Up Stream of Sharon Creek (Station 1840+00)	1,200	8,100
Sharon Creek (Mile 0.66)	1,800	9,800
Cooper Creek (Mile 0.1)	2,400	11,700
Center Hill Road (Station 1422+50)		10,300*
At Barrier Dam (Station 1024+00)		9,700*

\* Reduction of flow due to tunnel storage

With the above-mentioned intake structures diverting excess flows, flooding along Mill Creek, Kemper Road Tributary, and Sharon Creek should be eliminated for the 1% chance flood event within the floodplain of Mill Creek. Even with the intake structure located at the confluence of Mill Creek and East Fork Mill Creek, there would still be some residual flooding located upstream of the intake structure on East Fork. For this reason, minor channel modification would be needed to eliminate flood damages along this stream. Therefore, analysis of other tributaries to Mill Creek has been evaluated to determine if additional modifications to other streams would be required. This analysis indicates that a channel enlargement for about a 1500-foot reach would be required for a Beaver Run/Champions Tributary that enters Mill Creek near Station 1974+70. A channel modification of about a 1,100-foot reach, beginning at mile 0.575 and continuing upstream to mile 0.78, would also be needed for a Keebler Tributary that enters Mill Creek near Station 1924+70. Refer to Appendix IV for the water surface profiles for the TU alternative.

### 10.9.3 Environmental

Environmental restoration elements of this alternative include the planting of trees and shrubs around the surface areas of the seven floodwater drop shafts. The planting of trees and shrubs would be coordinated to complement the endemic vegetation of the surrounding area and to provide wildlife habitat and a visual screening around the shaft locations.

**TABLE 10.9.4.1**  
**Real Estate Costs for TU Alternative**

Component	Acres	Unit Value	Total Value
<b>Fee Simple</b>			
Shaft Sites	9.2	\$31,667	\$291,000
Minerals [None]			\$0
Timber [None]			\$0
Fee Improvements [None]			\$0
<b>Easements</b>			
Subsurface Easement	142.5	\$6,455	\$920,000
Channel Improvement Easement	6.7	\$60,000	\$402,000
Levee Easement	25.4	\$58,859	\$1,495,000
Road Easement	3.4	\$7,500	\$26,000
Temporary Work Area (Disposal)	100	\$30,000	\$3,000,000
Temporary Work Area (Access)	5.6	\$5,000	\$28,000
Subtotal – Easements			\$6,162,000
Severance Damages (20% Shaft Sites)			\$59,000
Total Land, Improvements, and Damages	292.8		\$6,221,000
Contingency (35%)			\$2,177,000
			\$8,397,000
<b>TOTAL ESTIMATED LAND COSTS ®</b>			<b>\$8,400,000</b>
Relocations [None]			\$0
Administration: 670 Tracts			
Non-Federal Administrative Costs [\$5,000]			\$3,350,000
<b>TOTAL LERRD</b>			<b>\$11,750,000</b>
Federal Administrative Costs [\$5,000]			\$3,350,000
			\$15,100,000
<b>TOTAL REAL ESTATE COSTS</b>			<b>\$15,000,000</b>

Notes: price level in 2002 dollars

The construction cost estimate for the TU alternative was primarily based on the estimate prepared by Parsons-Brinckerhoff for MSD, which was incorporated into MCACES by CELRL. The resulting cost estimate included construction; real estate; environmental mitigation; construction management; planning, PED; tunneling; and mobilization/demobilization. The TU alternative is estimated to cost \$881,766,000 (Table 10.9.4.2).

**10.9.4b Benefit Analysis**

The HEC-FDA program was used to estimate flood damage to structures in the study area for the TU alternative, while a separate analysis was used to estimate the damage to basements from sewer back-up. With risk and uncertainty factored in, the average annual damage for the TU alternative was estimated at \$5,188,000 (base year 2017). Table 10.9.4.4 displays the damage estimates for selected years.

**TABLE 10.9.4.4**  
Average Damage Estimates for TU Alternative (thousands of dollars)

Year	N <sup>15</sup>	Overbank Flooding	Sewer Back-up	Total
2002		\$35,409	\$9,400	\$44,809
2003		\$37,200	\$9,400	\$46,600
2004		\$39,000	\$9,400	\$48,400
2005		\$40,800	\$9,400	\$50,200
2006		\$42,600	\$9,400	\$52,000
2007		\$44,400	\$9,400	\$53,800
2008		\$46,200	\$9,400	\$55,600
2009		\$48,000	\$9,400	\$57,400
2010		\$49,800	\$9,400	\$59,200
2011		\$51,600	\$9,400	\$61,000
2012		\$53,400	\$9,400	\$62,800
2013		\$55,200	\$9,400	\$64,600
2014		\$57,000	\$9,400	\$66,400
2015		\$58,836	\$9,400	\$68,236
2016		\$58,836	\$9,400	\$68,236
2017	1	\$2,888	\$2,300	\$5,188
2018	2	\$2,888	\$2,300	\$5,188
2019	3	\$2,888	\$2,300	\$5,188
2020	4	\$2,888	\$2,300	\$5,188
2021	5	\$2,888	\$2,300	\$5,188
2026	10	\$2,888	\$2,300	\$5,188
2031	15	\$2,888	\$2,300	\$5,188
2036	20	\$2,888	\$2,300	\$5,188
2041	25	\$2,888	\$2,300	\$5,188
2046	30	\$2,888	\$2,300	\$5,188
2051	35	\$2,888	\$2,300	\$5,188
2056	40	\$2,888	\$2,300	\$5,188
2061	45	\$2,888	\$2,300	\$5,188
2066	50	\$2,888	\$2,300	\$5,188
Total		\$144,384	\$115,000	\$259,384
Present Value (2017)		\$46,321	\$36,894	\$83,216
Avg Annual Damage (2017)		\$2,888	\$2,300	\$5,188

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

<sup>15</sup> "N" equals the number of years after project completion. The base year is the earliest year that benefits would accrue under this alternative.

alternative would not be cost effective ( $BCR < 1$ ). However, additional benefit categories will be evaluated during later stages that may make the TU alternative cost effective. Since the tunnel would be constructed 200-300 feet below grade, the environmental impacts would be minimal. Plantings in the drop shafts areas would be added for ecosystem restoration. Tunnel construction would produce limited waste and HTRW sites would have limited disturbance, primarily at the shaft sites. Acceptance of this alternative by the community and local governments would be high due to the added benefit of CSO reduction.

Based upon the evaluation to date, the TU alternative is marginal in satisfying the four evaluation criteria of the USACE planning guidelines listed in Section 2.4; namely the TU is found to be marginal with respect to "efficiency" due largely to its high cost (average annual costs are somewhat greater than average annual benefits). However, the TU alternative fully satisfies the other three criteria, and is the locally-preferred alternative. Also, it is anticipated that more benefits will be delineated (particularly sewer-backup and transportation delay benefits) during a more detailed Stage 3 evaluation.

## **10.10 DEEP TUNNEL 2**

### **10.10.1 Description and Features**

The TU-2 alternative was a modified version of the TU alternative. The major differences are that the tunnel in the TU-2 alternative would be approximately half the length and it would not address CSOs. The tunnel would start at the same location, but it would terminate at the previously modified channel sections at Center Hill Road. The TU-2 alternative would take advantage of the previously modified channel to provide protection up to 1% chance flood event. As in the TU alternative, the tunnel would be bored through a limestone layer at an average depth of about 300 feet beneath the surface, have a diameter of 31 feet and vertical shafts would convey creek overflows into the tunnel. Access for tunneling (removal of muck and insertion of support elements) would be performed through the drop shafts, which later would be utilized for hydraulic input. Maps showing areas of impact for the TU alternative can be found in Appendix XI. These maps should be used to estimate the impacts and alignment of the TU-2 alternative.

In addition to the deep tunnel, a few short levee segments and modifications to the Mill Creek channel and some tributaries would be required (Table 10.10.1.1). Channel modifications would consist of channel widening with a riprap toe. Automatic gate closures would be installed where roads cross a floodwall. No residential or commercial structures would be demolished during the implementation of the TU-2 alternative. Construction of the TU-2 alternative would begin in 2007 and be completed in 2011.



In-channel improvements would be limited to boulder and cobble constructions at 500-foot intervals in previously modified sections to create artificial riffles to improve fish habitat. Artificial riffle areas would provide flow modification and serve as physical water energy dissipaters under normal flow conditions.

Water quality improvements would result from the reduction of CSOs entering Mill Creek. CSO issues would be addressed by the MSD CSO reduction plan, entitled *Mill Creek CSO Reduction Plan, in Lieu of a Deep Tunnel Parallel to Mill Creek* (October 2002). Additional water quality improvements could result from protecting industrial facilities that use solvents and other chemicals in their manufacturing process. Protecting these industrial facilities from flooding may reduce the potential for contamination of floodwaters and subsequent transport of contaminants throughout the floodplain.

#### **10.10.4 Economics**

##### **10.10.4.a Cost Analysis**

The real estate costs were based on acquiring the lands and easements necessary to construct the TU-2 alternative. In accordance with ER 405-1-12, Chapter 5, Estates, the following estates are required for real estate acquisition: Estate 1, Fee; Estate 9, Flood Protection Levee Easement (also Floodwalls); Estate 11, Road Easement; and Estate 15, Temporary Work Area Easement. One non-standard estate would be required. The subsurface easement for a tunnel would be prepared after all requirements and restrictions have been identified. It would require approval prior to use. The estimated cost for real estate acquisition is \$11 million.

**TABLE 10.10.4.2**  
**Total Cost Estimate for TU-2 Alternative**

<b>Feature</b>	<b>Cost</b>
Section 1	\$18,000
Section 2	\$7,514,000
Section 3	\$15,000
Section 4A	\$13,000
Section 4 B	\$13,129,000
Section 5	\$269,000
Section 6	\$536,000
Section 7	\$3,123,000
Section 8	\$214,000
Tunnel	\$303,551,000
Real Estate	\$11,000,000
Environmental Mitigation	\$12,479,000
Construction Management	\$20,941,000
PED	\$35,899,000
Mobilize/Demobilize	\$32,474,000
Utility Conflicts	\$1,807,000
Traffic Control	\$856,000
<b>TOTAL</b>	<b>\$443,837,000</b>

Notes: price level in 2002 dollars

Completion of the TU-2 alternative is estimated for 2011, with the alternative base year being 2012. For this analysis, the construction costs were assumed to be evenly distributed over the construction period. The average annual first cost was calculated by annualizing the first cost and interest during construction. The alternative's average annual cost was calculated by adding the average annual first cost and the average annual O&M cost. The average annual cost for the 2012 alternative base year was estimated at \$32,780,000 (Table 10.10.4.3). For comparison, this cost was adjusted to a project base year of 2010 and is estimated at \$29,243,000. See Appendix V for detailed life cycle costs.

**TABLE 10.10.4.3**  
**Average Annual Cost for TU-2 Alternative**

<b>First Cost</b>	<b>Interest During Construction</b>	<b>Avg Annual First Cost (2017)</b>	<b>Avg Annual O&amp;M</b>	<b>Avg Annual Alternative Cost (2017)</b>	<b>Avg Annual Cost (2010)</b>
\$443,837,000	\$80,314,000	\$32,676,000	\$105,000	\$32,780,000	\$29,243,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

base year of 2012 to a project base year of 2010. Table 10.10.4.5 displays the total annual benefits for both the alternative and project base years.

**TABLE 10.10.4.5**  
**Benefit Calculations for TU-2 Alternative**

<b>WO Alternative Damage (2012)</b>	<b>TU-2 Alternative Damage (2012)</b>	<b>Avoided O&amp;M Cost</b>	<b>Annual Benefit (2012)</b>	<b>Adjusted Annual Benefit (2010)</b>
\$67,618,000	\$12,257,000	\$34,000	\$55,395,000	\$49,418,000

Notes: discount rate 5.875%; 50-year project life; price level in 2002 dollars

#### **10.10.4c Economic Evaluation**

The economic feasibility of the TU-2 alternative was determined by comparing the benefits and the costs (Table 10.10.4.6). The TU-2 alternative has a BCR greater than 1.0, indicating that it would be economically justifiable.

**TABLE 10.10.4.6**  
**Economic Evaluation of TU-2 Alternative (base year 2010)**

<b>Annual Benefit</b>	<b>Annual Cost</b>	<b>BCR</b>	<b>Annual Net Benefit</b>
\$49,418,000	\$29,243,000	1.69	\$20,175,000

Notes: price level in 2002 dollars

#### **10.10.5 Summary**

The TU-2 alternative completely and effectively addresses the objective of providing flood reduction. The TU2 alternative would be engineeringly feasible. The environmental impacts would be minimal. Plantings and streambed improvements would be made along the existing channel sections and around the surface water drop shafts. Estimates indicate that the TU-2 alternative would be cost effective. Since CSOs were not addressed with this alternative, community acceptance would be moderate, but somewhat less favorable than the TU alternative.

Based on the screening-level evaluation completed to-date, the TU-2 alternative does satisfy all four evaluation criteria of the USACE planning guidelines as listed in Section 2.4. However, more work will be needed (during later detailed studies), particularly to identify the full costs and complete an analysis of the hydraulic impacts of this alternative.

## Appendix IV – Water Surface Profiles

The following sections provide a visual depiction of peak flood levels on Mill Creek for various storms and conditions. The water surface profiles were computed using the U.S. Army Corps of Engineers River Analysis System (HEC-RAS) developed by the Hydrologic Engineering Center. Water surface elevations are presented for each river station, starting at the Barrier Dam ump station at the confluence of Mill Creek and the Ohio River, continuing upstream to the study limit.

Profiles have been included for the following conditions:

- Existing Channel with Current Flows
- Existing Channel with Future Flows
- Channel Modification Plans with Future Flows
- Wall/ Levee Plan with Future Flows
- Tunnel Plan with Future Flows.

As described in the text the evaluation of the non-structural alternatives (RL, NS, & NS-2) were based on the existing channel conditions.

For each condition the profiles present the Stream Bed (the lowest elevation in the channel), and the location of the numerous bridges crossing the channel. For most bridges there is a solid vertical line representing the bridge location, extending from the low chord (where flow reaches the bottom of the bridge superstructure and transitions to pressure flow), upwards to the top of road (where flow overtops the roadway). In some cases the bridges are located so far above the channel and flow lines that the bridge elevation is simply identified with an up-arrow on the bridge label.

A total of eight (8) flow lines are presented on the stream profiles. Each of the flow lines represents the peak water surface for a different stream discharge/ storm condition. The uppermost flow line represents the discharge with a 0.2% chance of being equaled or exceeded in any single year. Such a condition is often referred to as the 500-year storm.

Starting from the uppermost flow line, the following discharge/ storm conditions are presented on profile plots:

- 0.2 % annual chance of being equaled or exceeded (sometimes called the 500 yr. storm)
- 1 % annual chance of being equaled or exceeded (sometimes called the 100 yr. storm)
- 2 % annual chance of being equaled or exceeded (sometimes called the 50 yr. storm)
- 4 % annual chance of being equaled or exceeded (sometimes called the 25 yr. storm)
- 10 % annual chance of being equaled or exceeded (sometimes called the 10 yr. storm)
- 20 % annual chance of being equaled or exceeded (sometimes called the 5 yr. storm)
- 50 % annual chance of being equaled or exceeded (sometimes called the 2 yr. storm)
- 98 % annual chance of being equaled or exceeded (a frequent, nearly annual storm)

The stream profiles may be used to identify the hydraulic effect of the various plans. Some alternatives, such as the channel and tunnel, are effective because they reduce the water levels and therefore the extent and frequency of damage. This is reflected in the lower water surface flow lines for these alternatives when compared to the without project profiles. In contrast, the wall / levee plan is effective by preventing the spread of water into the developed floodplains. Constraining the flow results in higher water surface profiles in some locations.



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Southwest District

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January 8, 2003

Mr. Steve Vierling  
ATTN: PM-PF  
U.S. Army Corps of Engineers  
P.O. Box 59  
Louisville, Kentucky 40201-0059

Dear Mr. Vierling:

Thank-you for inviting Ohio EPA to participate in the "Scoping Meeting" on November 6, 2002, to discuss the Mill Creek Flood-Damage Reduction Project. We appreciate the opportunity to express our opinions and concerns, and to share with you the goals of the State of Ohio for the Mill Creek watershed.

Mill Creek was one of the first streams in Ohio to be identified from Section 303(d) of the Clean Water Act (33 U.S.C. 1313) for the Total Maximum Daily Load (TMDL) program which is designed to restore waterbodies to meet their designated uses. The Mill Creek mainstem has been codified in the Ohio Water Quality Standards of the Ohio Administrative Code 3745-1-30 with aquatic life use designations of Warmwater Habitat (WWH) from its headwaters to river mile 7.9 and Modified Warmwater Habitat (MWH) from river mile 7.9 to the mouth due to prior channelization. The mainstem has also been designated as a Primary Contact Recreation Water, and both Agricultural and Industrial Water Supply designations apply. The watershed is complex, with many types of pollution and pollutants causing impairment and preventing the attainment of the use designations. Along with several pollutants, habitat modification has also been identified as a cause of degradation in the watershed.

It is because of this complexity that Ohio EPA decided to phase in the restoration process for Mill Creek. The first phase of the program is focused on dealing with excess nutrients. Ohio EPA worked with many local stakeholders during this initial phase of the TMDL development. The stakeholders of the watershed asked to develop a holistic Watershed Action Plan (WAP) which will address the goals of the TMDL process, including habitat restoration, and many other issues.

It is from this perspective that we express some of our concerns regarding the six proposals presented at the Scoping meeting for the Mill Creek General Reevaluation Report (GRR) Study. Ohio EPA was provided with only minimal descriptions of the proposals so our comments are based on these summaries. The proposals that appear



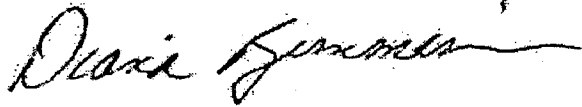
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Christopher Jones, Director



consideration in your decision process. Please contact me at 937-285-6440 or Hugh Trimble at 937-285-6444 with any questions or comments.

Sincerely,

A handwritten signature in cursive script, appearing to read "Diana Zimmerman", with a long horizontal flourish extending to the right.

Diana Zimmerman  
Environmental Supervisor  
Division of Surface Water

cc: Hugh Trimble, DSW

DZ/br